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An Integrated Method Used to Value Recreation Land—a Case Study of Sweden

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Abstract

There is a strongly symbiotic relationship between TR (Tourism and recreation) activities and land use in macro-scale. This paper developed an alternative method for delimiting the spatial extent of recreation activity in the landscape by integrating the assessment of land development intensity into the approach to assess accessibility of recreation activity. Two factor groups of social and natural comprising 6 separate sets were formed to account for the land development intensity index with the example of Sweden. Land development intensity zones were divided by lowest, very low, low, middle, high, very high and highest. According to spatial decision matrix, six patterns are eventually divided by urban and rural residence, front-country, backcountry, remote, semi-primitive, primitive. The approach provides a beneficial tool for recreational management zoning.

Keywords: land development intensity; TOS; ROS; Sweden; GIS

1. Introduction

With expansion in the demand for recreational services, the management and spatial plan of recreational settings has come a number of complex policy issues(Roger N.1979).In response to rapidly growing recreational use and the increasing impact on resources, the USDA Forest Service introduced the ROS(Recreation opportunity spectrum) concept to describe the range of recreational activities that might be feasible in a given location. Usually, the types of opportunities available is distinguished by varying conditions, ranging from modern and developed to primitive and undeveloped, i.e. modern , semi-modern semi-primitive, primitive(Roger N.1979) or urban and rural, backcountry, front-country, remote area, and wilderness (Karen Joyce, 2011).

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With the development of the computer, geographical information system tools was introduced in land use planning and relevant resource management. GIS-based methodologies for land use planning roots in transparent overlays and computer cartography (Steinitz et al., 1976). Applications range has extended from land use suitability analysis (F.C.Dai et al., 2001; Pham Duc Uy, 2008, Aleksandra M. Tomczyk,2011) to specific resources assessment such as landslide risk potential and green space planning(H.Go´meza, T. Kavzoglu,2005; Ole Hjorth Caspersen,2010).

Efforts to develop an approach to assess the recreation suitability originate with Duffield and Coppock's (1975) computer-based delineation of recreational landscapes. Recreation suitability index models were first suggested by Levinsohn et al. (1987), and then a geographic information system (GIS) based methodology was developed for mapping recreation terrain suitability using recreation terrain suitability indices (RTSI) by A.D. Kliskey(2000). Gobster et al. (1987) implemented the widely used recreation opportunity spectrum (ROS) approach using GIS in support of recreation policy development.

The recreation opportunity setting(Roger N.1979) is a combination of physical, biological, social, and managerial conditions that give value to place. Land development intensity was also significantly influenced by social, environmental and managerial factors. There is a strongly symbiotic relationship between TR (Tourism and recreation) activities and land use (A.M. Williams,2009) in macro-scale.

The methods of TOS (Tourism opportunity spectrum) and ROS (Recreation opportunity spectrum) (Stephen W Boyd, 1996) are essentially to assess land development intensity, i.e. to assess the extent and degree of what human impact on environment and delimit the spatial extent of recreation activity in the landscape. Its main objective is to attain consistency in the management of recreation through the integration of recreation and resource management planning.

Recreation opportunity can be spatially assessed, measured, and managed, and it is very important for enabling comparison of amounts of different types of opportunity, and to help inform visitors on the level of skill required when visiting unfamiliar locations(Karen Joyce,2009).At present, there is not much research on the intensive use of the land in national scale and no literature present to integrate ROS and land development intensity. The existing research mainly focuses on the overall analysis of the land use in cities and developed zones(Yang, 2007;Wu and Qu, 2007;Wu et al., 2006; Bo-sin Tang,2010). The aim of paper attempts to present an alternative method for delimiting the spatial extent of recreation activity in the landscape by integrating intensity of land development into the approach to value accessibility of recreation activity by using GIS. The approach is demonstrated with an example of Sweden.

2. Methods and data

2.1. Methods

An alternative method was developed for delimiting the spatial extent of recreation activity in the landscape by integrating the assessment of land development intensity into the approach to assess accessibility of recreation activity.

The integration of natural environment, socio-economic conditions and personal preferences eventually formed the occurrence of leisure recreation behavior. In this section, the various factors impacting the land development intensity are provided. Two factor groups comprising 6 separate sets account for the land development intensity, which include elevation, slope, land use type, population density, distance to road, distance to residence(Fig.1).

Topography is an important determinant factor of shaping land development intensity. In general, regions with low elevation are more suitable for human occupation than those at high elevation. A higher slope value indicates a steeper incline. A higher slope indicates a smaller chance to be used by human activities.

Distance parameters were employed to control the impact extent. Distance to road is used to describe the degree to which a recreation or tourism product, service, or environment is available to as many people as possible. It can be viewed as the “accessibility” and benefit from tourist or visitors. Distance to residence is also used to describe the chance or opportunity of human exerting an impacton the environment. In general, a higher population density indicates a higher land development intensity. The different land use patterns are related to different human activities.

With the key parameters identified, a metric for land development intensity index now can be formulated. Considering correlation between the chosen factors, a weight index approach was used. The arithmetic formulae of land development intensity index are defined as follows:

$$f(x) = \sum_{n=1}^{\infty} w_i F_i \tag{1}$$

Here, f(x) present the score of land development intensity index, Wi is the weight of i factor.Fi is score of i factor.

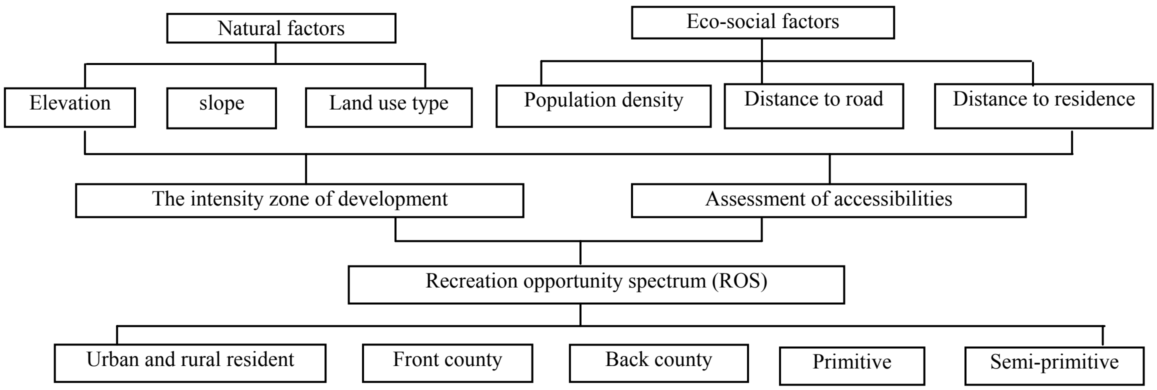

Fig.1. The flow chart of integrated method used to value recreation land.

2.2. Data resource

The national land cover database derived from Corine land cover 2006. It is the year 2006 update of the first CLC database which was finalized in the early 1990s as part of the European Commission programme to COoRdinate Information on the Environment (Corine). Spatial resolution is 100*100meter. DEM data and administrative maps at the county level come from Corine database. Spatial resolution of DEM data is 1000*1000meter. The traffic data come from OpenStreetMap data(http://download.geofabrik.de/osm/europe/),Population data(Census 2001),provided by Eurostat (http://epp.eurostat.ec.europa.eu). Spatial resolution of Population data is 100*100meter.

2.3. GIS spatial analysis and parameter description

There are two stages to form final results. The first stage involved calculation of development intensity index and division of land use development intensity zone. The second stage involved analysis of accessibility and division of ROS zone according to spatial decision matrix (Tab2,Fig.1).

In first stage, data of each parameter is extracted from both land cover, DEM and population data sets based on the composite map and a series of buffers were developed around roads, and residence. Every factor hierarchy map formed according to the parameters and thresholds(Tab1). The weight was set up and the land development intensity index was calculated according arithmetic formulae(1). The weighting reflects the relative importance of each variable. After consulting the views of experts in the field, the weight were finalized. The weight of elevation, slope, population density, distance to road, land use is respectively 10%,20%,30%,10%,10%,20%(Tab1).

The elevation data and slope were developed from the digital elevation model(DEM). Elevation grading maps are extracted by five classes (below 55 m, 55-94 m, 94-121 m, 121-155 m, ≥ 155 m), and slope grading maps are extracted by five classes: below 3°(flat), 3-8°(slight slope), 8-15° (moderate slope), 15-25°(abrupt slope), ≥ 25°(steep slope) (Chen, Y, 2006; Fan, J.2009;Yong Xu.2011).

Sweden is a country in Northern Europe on the Scandinavian Peninsula in which about 15% of Sweden lies north of the Arctic Circle. The population density is relatively low in Sweden. The area below 14 person occupies 90,82% of the total coverage (based on raster statistics), 14-63 person occupies 7,81% total coverage. Above 63 person occupies1,38% total coverage. In our research, the area less than 14 people was further identified as sparsely populated zone; the areas with 14-63 people was identified as moderate population density zone; more than 63 for the densely populated zone.

Tab.1. The key factors, parameters, and statement of calculation

Factors	Factors and weight	Parameters and thresholds	Statement of calculation
Natural (topography)	1Elevation 10%	≤ 55, 55-94, 94-121, 121-155, ≥ 155	Obtain the elevation data from Corine.
	2Slope 20%	≤ 3°,3-8°,8-15°,15-25°, ≥ 25°	Use GIS abstract the data
Social	3Population density 30%	≤ 14, 14-63, ≥ 63	Obtain the population density data from Corine
	4Distance to residence10%	≤ 0.5, 0.5-2, ≥ 2 km	Using Arcgis10 to abstract rural residence ,spatial analysis tools was used, Euclidean distance, set up50000 the max distance.
	5Distance to main road 10%	≤ 0.5, 0.5-2, 2-10, ≥ 10 km	main road data was abstract by using GIS. Spatial analysis tools /distance/Euclidean distance.
Current land use pattern	6land use20%	Artificial surfaces, agricultural areas, forest and semi natural areas, wetlands, water bodies.	
traffic	Distance to road	Within 0.5km of main road	Front country
		beyond 0.5km and within 2km of main road	Backcountry
		2 km /10km. All land that has not yet been classified until a linear distance of 10000m of main road.	Remote area(Karen Joyce,2009)
		Any other land according the result of elevation, slope, population density, and distance to road	Primitive and semi-primitive

The road typically involves dividing by the Maxspeed, it was classified into trunk, motorway roads, primary, secondary, tertiary pedestrian, bridleway, cattle, snowmobile, track and trail, bus guideway, path, footpath and cycleway. In our research, we used the main road buffer to identify the ROS in the scale of national. The main road includes motorway roads, Trunk, Primary. The method can be seen in the tab1.

Corine land cover data contains 44 sub-classes which was integrated into five sub–categories. According to investment intensity or strength of the human impact on the environment, it can be descended as following: urban and rural residence, agricultural areas, forest and semi natural areas, open spaces and unused land, and water bodies. The attributes were extracted by using ArcGIS 10(Tab1).

Tab.2. Spatial decision matrix

accessibility classification / land development intensity zone		Urban and rural residence	frontcountry	backcountry	remote	Semiprimitive	primitive
Urban and rural residence	highest	√					
Within 500m of main road			√				
500m-2km				√			
	Very high		√				
	high			√			
2 km-10 km					√		
	middle				√		
≥ 10 km	low					√	
	Very low						√
	lowest						√

The final analysis was developed into a single map through an overlay process. 7 hierarchies of land development intensity index were formed according to land development intensity index which are named as highest, very high, high, middle, low, very low, and lowest zone(Fig2).

In the second stage, the TOS classification was eventually performed. At first, accessibility is valued according to the specific spatial rules(tab1). The accessibility classification was performed progressively by eliminating land from the classification as it is categorized. In this way, the urban and rural class was the first to be generated then removed from subsequent classification. Then front-country, remote and backcountry. The area within 0.5km of main road was deemed to be in a Front-country region, where beyond 0.5km but within 2km of main road was deemed to be in a backcountry region. 2 km - 10km was deemed to be in a remote area region (Karen Joyce,2009). Any other land was deemed to be in a primitive and semi-primitive region. At last, ROS classification is formed by using spatial decision matrix(Tab2). The left column is land development intensity zone and the top row is accessibility classification. This means that land development intensity is an important reference to decide the final ROS class. The class of highest index zone of land development intensity response to the urban and rural residence; the very high zone within 2km of main road was merged into front-country; high was merged into backcountry; and the middle zone was merged into remote. Low, very low and lowest response to semi-primitive and primitive. According to spatial decision matrix (Tab.2), six patterns are divided by urban and rural residence, front country, backcountry, remote, Semi-primitive, and primitive (Fig 3).

3. Results and discussion

3.1. Distribution of ROS zone and application

The classification demonstrates over 50% classed as either primitive or semi-primitive. Primitive occupies the largest land area with just under 35% total coverage. By contrast, semi-primitive opportunities represent less than 20% of the total managed land. The majority of semi-primitive or primitive regions occur in the north of Sweden. Remote and back county cover a total of 22,41% and 9,83% respectively of total land area. Front country comprises only 3,32% of the total area. About 1,30% of the total land has been classified as urban and rural residence(Fig.3).

ROS zone varies in different places, for example, more than 77%of land in the Norrbottens län has been classified as primitive (48%), and semi-primitive (29%), nearly 11% as remote. Frontcountry represents 1% of the land coverage, with 4% of the land area total allocated to backcountry. But on the contrary for south of Sweden, more than 69%of land in the Skåne län has been classified as remote (39%), and backcounty (30%). Primitive and semi-primitive cover a total of 4% and 9% respectively of total land area.

Though ROS needs to be more thoroughly tested in Sweden, this approach has provided a beneficial tool for recreational management zoning. Through the ROS classification, different stakeholders can benefit from it. As a visitor, he can assess and compare the availability of different types of recreation opportunities in an objective manner to decide where he will go to spend his leisure time. Government departments can make a smart tourism development plan so as to keep resources being used sustainable, and, at the same time, offering more services to meet increasing demand. More importantly, through integration of land development intensity, it can facilitate the strengthening tourism resource management as well as land use allocation options relevant to tourism.

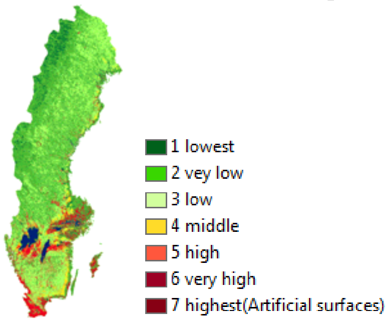

Fig.2. intensity zone

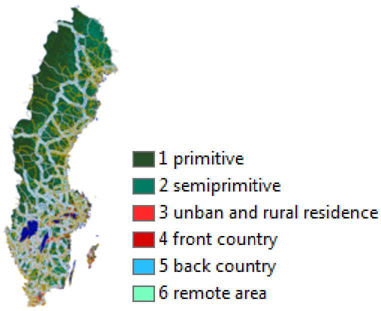

Fig.3. Recreation opportunity spectrum

3.2. Limitation and future work

ROS classification is essential to reflecting land carrying capacity of different regions for current population aggregation, industrialization and urbanization development, traffic distribution, and topography. However, it is hard to quantitatively describe all the contents. Therefore, some issues could be further considered to meet practical purposes and demand.

Subdivision of the ROS classification should be included in future assessments to improve upon the methodology or can be improved in regional and local scale. The management, tourists experience, and distribution, and qualities of landscape should be further considered in regional scale or local scale in future research.

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